



7.2 Daily Egg Production Method

Egg Production,
Adult Life History Parameters,
Spawning Stock Biomass Estimation, and
Data Management

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Coastal Pelagic Species Life History Program



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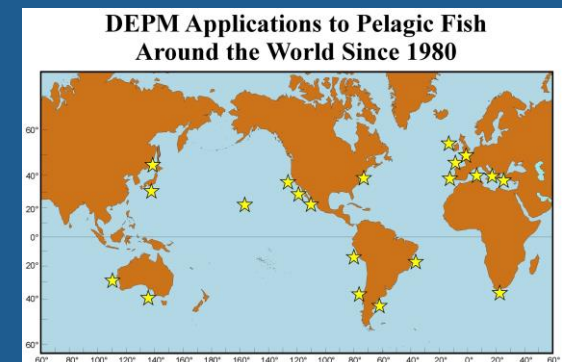
Outline

- Daily Egg Production Method (DEPM)
 - Brief History
 - Objectives
 - Assumptions
 - Design
- Adult Fish Parameters
- Spawning Stock Biomass Estimation
- DEPM Data
 - Management
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DEPM History

- **1980's:** Development of the DEPM for anchovy by SWFSC (**Lasker 1985**);
- **1986:** Application of the DEPM to Pacific sardine by the California Department of Fish and Wildlife (CDFW);
- **1994-present:** Survey development and estimation of sardine spawning stock biomass by SWFSC (**Lo et al 2013**); and
- DEPM is currently applied to assess pelagic fisheries in 21 countries.



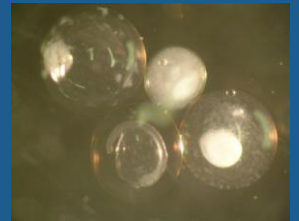
DEPM Survey Objectives

- Develop a SSB time series to be used as a relative abundance index in Pacific sardine stock assessment models;
- Monitor the long term variability in the larval production and/or in the abundance of other coastal pelagic species, such as: northern anchovy, Jack mackerel, Pacific mackerel, market squid, etc.; and
- Develop long time series of vital rates to help understand their variability with oceanographic conditions and their role in maintaining pelagic fish populations in the California Current Ecosystem.



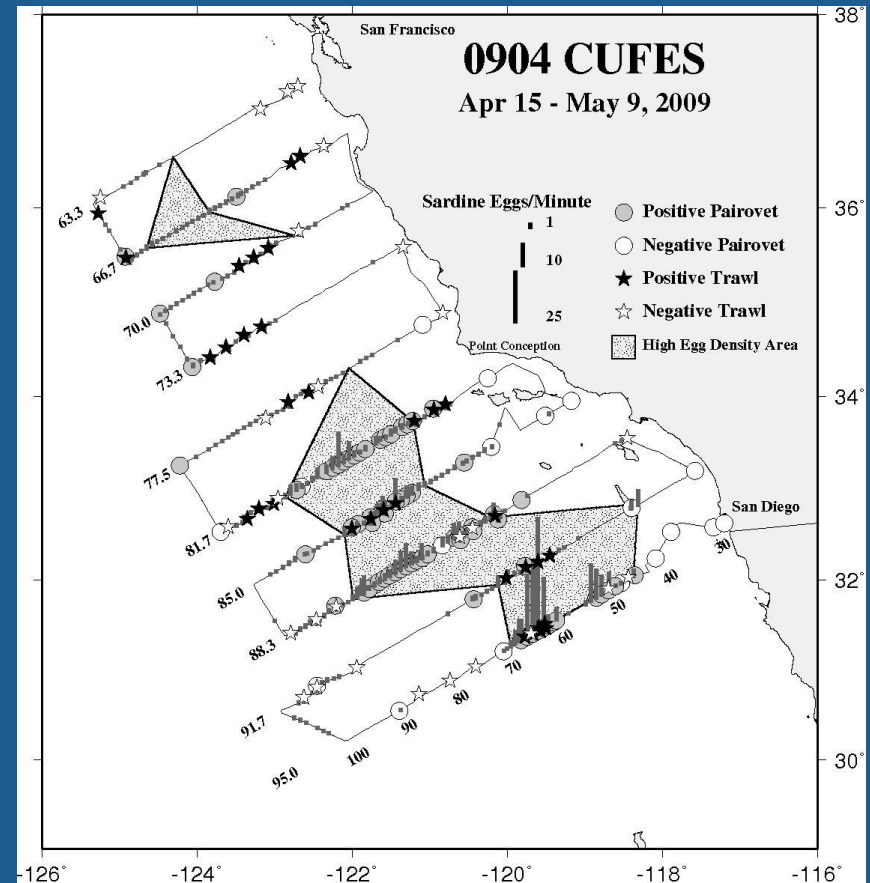
DEPM Survey Assumptions

- Fish species are multiple spawners and produce pelagic eggs;
- Female spawning rates can be measured during the day of trawling, and during 1 or 2 days prior to trawling; and
- The survey area encompasses the spawning ground.



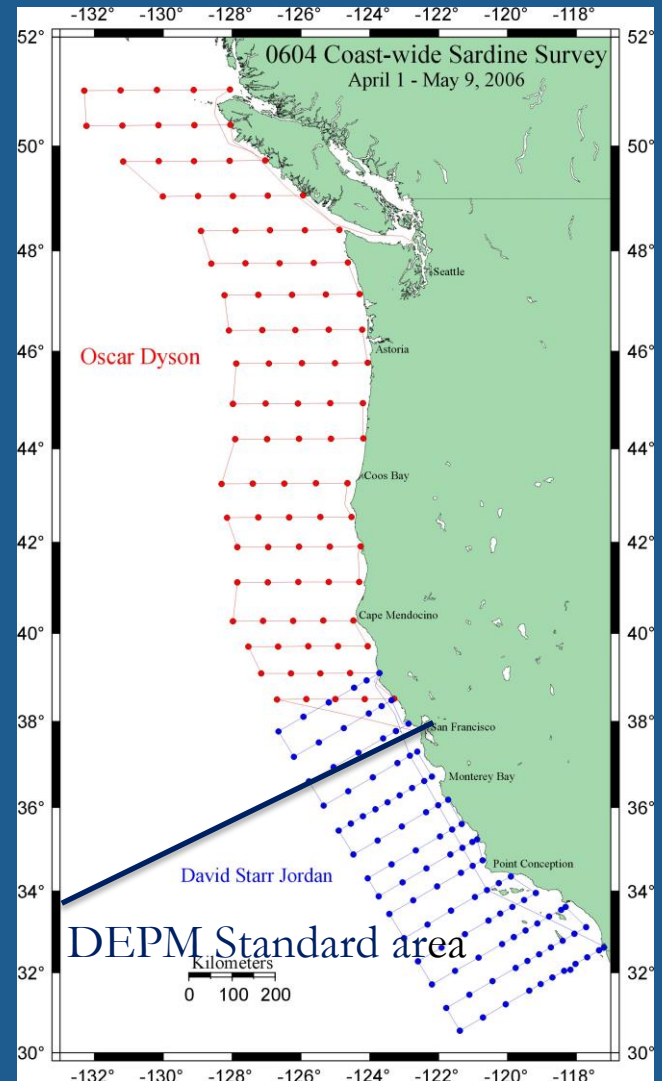
DEPM Survey Design

- The standard DEPM survey spatial and temporal frames:
 - San Diego to San Francisco;
 - Late March to early May;
 - 1994 to 2013;
 - Data collected are fully used in stock assessment of Pacific sardine.



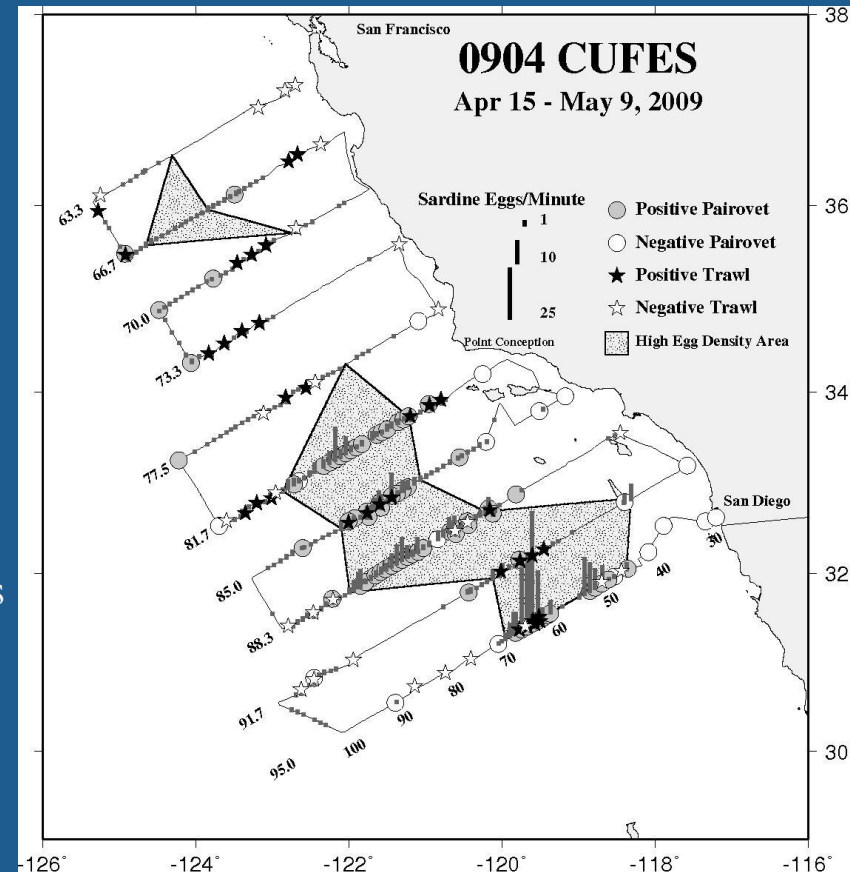
DEPM Survey Design

- The Coast-wide DEPM survey spatial and temporal frames:
 - San Diego to the border of Canada;
 - 2006 and 2008 spring surveys;
 - Data collected north of the DEPM standard area are not used in the stock assessment of Pacific sardine.



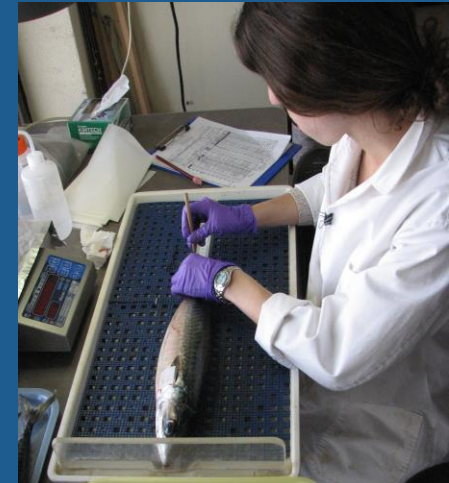
DEPM Survey Design

- Adaptive sampling allocation (Lo et al. 2001)
 - Egg and larval samples were collected using CalVET and Bongo nets from pre-determined CalCOFI lines and stations.
 - In addition to pre-determined stations:
 - CalVET tows were performed in areas where they were not pre-allocated when sardine egg densities from CUFES were higher than 1 egg per minute.

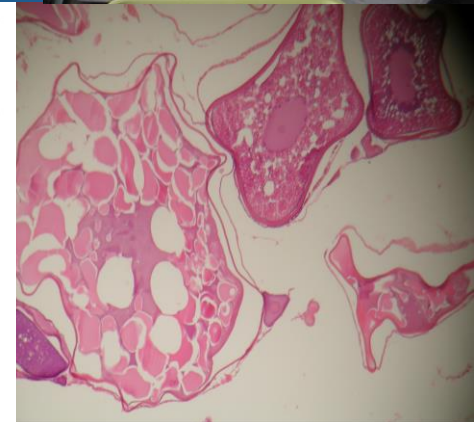
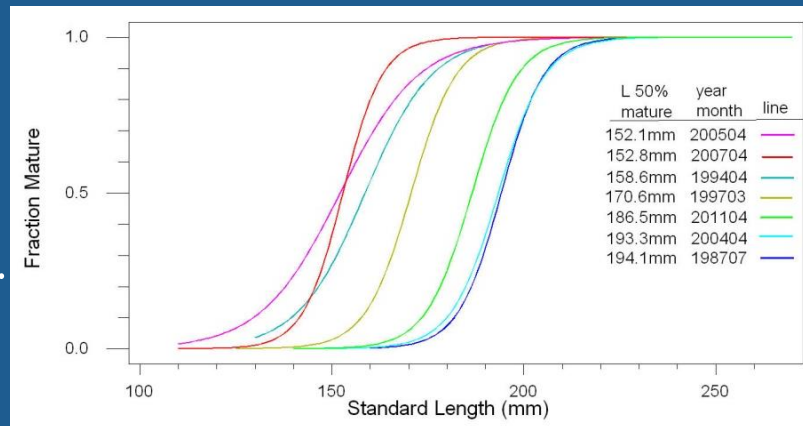


Adult Fish Parameters

- Fish sampled using a Nordic trawl:
 - 2-4 trawls collected at night time;
 - 50 fish randomly sampled from each trawl;
- Biological characteristics:
 - Length;
 - Weight;
 - Sex ratio.
- Dissection of ovaries:
 - Maturity;
 - Fecundity;
 - Spawning rates.

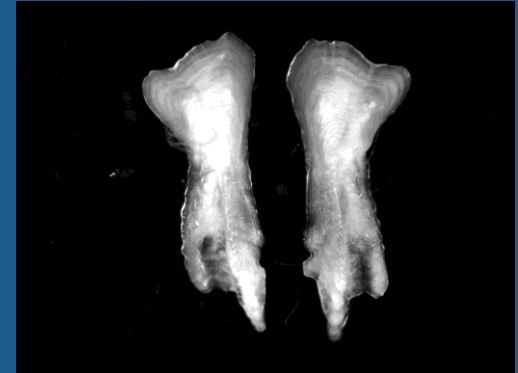
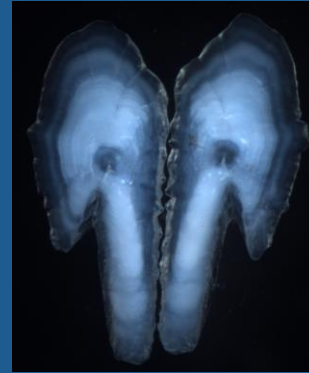


Sardine maturity-at-size(1987-2011)

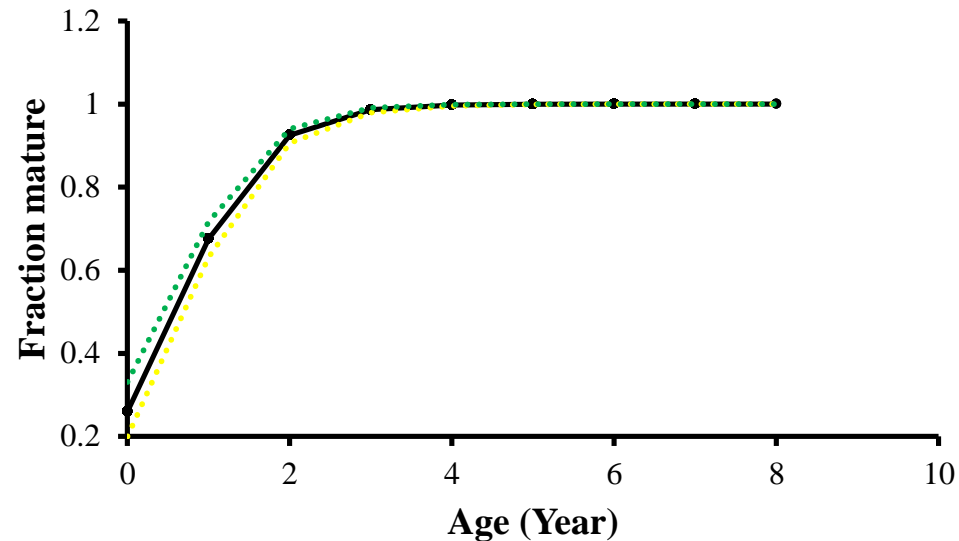


Adult Fish Parameters

- Extraction of otoliths:
 - Age and growth;
 - Chemistry and morphometry;
 - Stock structure and movement.
- Dissection of tissues:
 - Genetic analyses;
 - Stable isotopic composition;
 - Stock structure and movement.



Sardine maturity-at-age (2004-2010)



Spawning Stock Biomass (B_s) Estimation

P_0 = Daily egg production at age 0
per 0.05 m² of sea surface

A = Survey area

$$B_s = \frac{P_0 \times A}{RSF/W_f}$$

R = Sex ratio

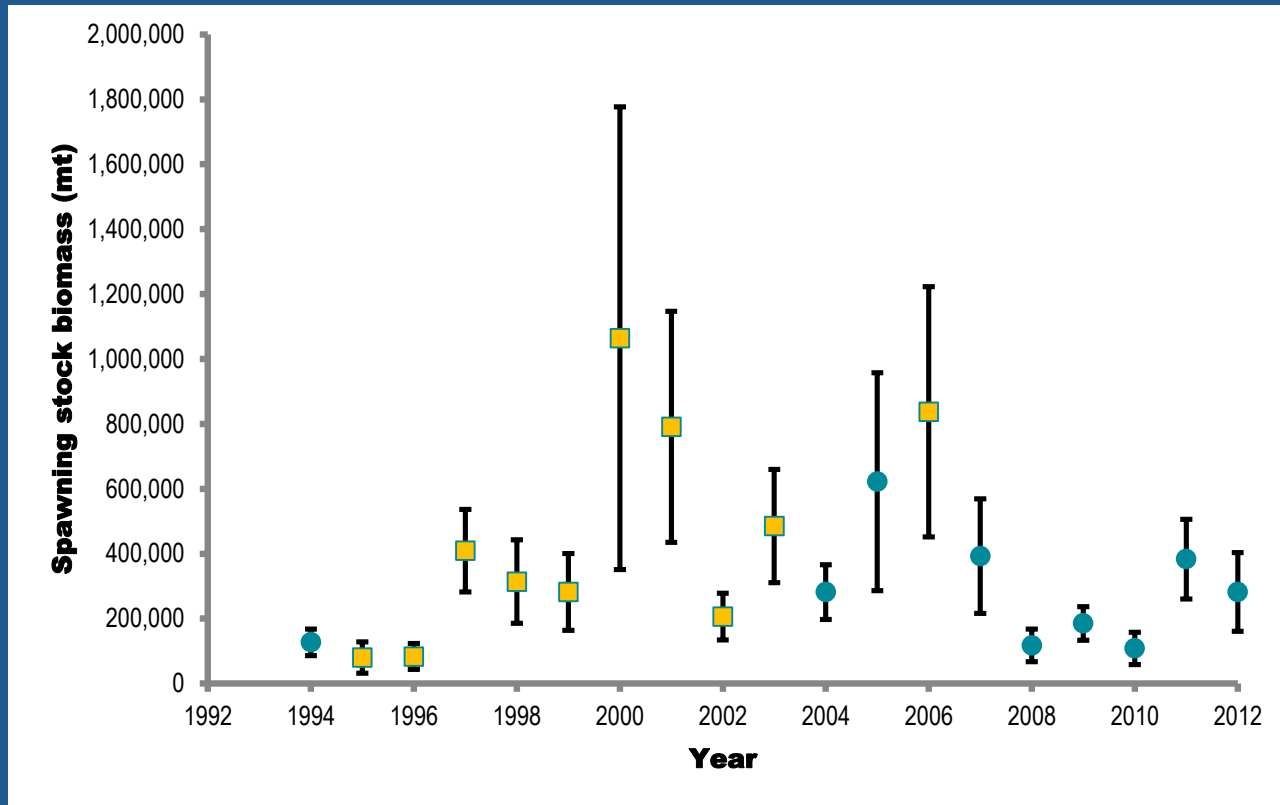
W_f = Female weight

S = Spawning fraction

F = Batch fecundity



Spawning Stock Biomass (B_S) Time Series



DEPM Data Management

- Field processing:
 - Environmental and basic biological data are recorded in the field;
 - Data procedures are documented in the CalCOFI manual (Jacobson et al. 2012).
- Laboratory processing:
 - Samples are processed on a species per species basis, prioritizing actively managed stocks;
 - Data procedures are not well documented.
- Database management:
 - Historically, DEPM data were managed by individual researchers;
 - These data are now being restructured, centralized, and managed by the Life History Program;
 - Data are shared on a request per request basis.



Data Strengths

- The DEPM method is well established, reviewed, and applied worldwide;
- Short cruises(2-3 weeks), during spawning seasons;
- Fishery independent estimation of spawning stock biomass;
- Longest index of relative abundance used in sardine stock assessment;
- Multispecies time series of life history parameters from larval to the adult stages.



Data Challenges

- For stock assessment:
 - High patchiness in the distribution of pelagic egg, larvae, and adult fish;
 - Difficulty in collecting representative adult samples for estimating life history parameters;
 - In some years a significant fraction of the sardine spawning core area may be located south of the DEPM standard area (i.e. in Mexico);
 - Highly labor intensive method: identification of eggs and larvae, assignment of egg stages, histological analysis, ageing, etc.;
 - Critical parameters for developing embryonic mortality curves have not been updated with changes in environmental conditions.



Data Challenges

- For ecological research:
 - Historically under-utilized due to;
 - Data management by individual researchers rather than using a centralized database;
 - Limited resources for data collection, processing and management;
 - The definition of a strategic plan for data management at the Center level.



Data Strategies

- For improving the DEPM survey process:
 - Determine optimal data processing and management units;
 - Center;
 - Division;
 - Program;
 - Develop a server that can be fully integrated with other database systems, such as ERDAP.
 - Improve allocation of resources between:
 - Data management;
 - Field sampling; and
 - Laboratory processing.
 - Determine the frequency for implementing the DEPM spring survey compared to other surveys;
 - Conduct laboratory experiments to update the DEPM life history parameters;
 - Strengthen research collaboration between the USA, Mexico, and Canada.



Questions?



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